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Common Yellowthroat nest in the Habitat Conservation Area, within Wascana Centre, with two Brown-headed Cowbird chicks, June 2013. *- Jared Clarke*

American goldfinch chicks *- Jared Clarke*

Blue Jay

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PLANTS

USING MULTIPLE DATA SOURCES ON SPECIES DISTRIBUTION FOR BIODIVERSITY ASSESSMENT: THE PRARIE CROCUS (ANEMONE PATENS) AS A CASE STUDY

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INTRODUCTION

Biodiversity assessment requires precise data about species distribution that are lacking for many areas because they are often incomplete or biased[1,2]. Recently, many studies are turning to the vast amount of information associated with the natural history collections, particularly herbaria. Herbarium data are useful for biodiversity exploration[3,4], identification of species of conservation concern[5], development of regional red lists[6], prioritizing of rare species for conservation planning[7,8], documenting effects of urbanization on flora[9] as well as assessment of spread and status of invasive species[10,11]. For a comprehensive analysis of studies on biogeographical patterns and various environmental questions where herbarium collections have been successfully used, refer to Lavoie[12]. In most cases herbarium data provide error-free information[5]. However, because of its existing limitations[2], additional sources of information are required to assist in biodiversity assessment and conservation planning.

Although mostly ignored until now, freely accessible citizen science phenology databases, which have advanced intensely during the last decades, might be another source of information about species

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distribution. Monitoring programs like NatureWatch in Canada are highly cost effective and provide a wealth of accurate data[13]. A part of NatureWatch is the PlantWatch program which was established by Nature Canada and Environment Canada's Ecological Monitoring and Assessment Network[14]. PlantWatch enables citizen scientists to get involved in research by recording flowering times for selected plant species and reporting these dates to databases or researchers. Based on the evidence of high effectiveness of the PlantWatch program[13], the phenological records from the regional databases like the Saskatchewan PlantWatch[15] might be a good data source about plant species distribution.

Field observations and surveys, recorded in the form of vegetation relevés, also provide valuable data for biodiversity assessment; however they are not often used for distribution analysis. Field surveys can help to establish how representative existing herbarium specimens are of general species range within the study area. In the course of the recent studies on sensitive plant species and vegetation communities in Saskatchewan[8], a few hundred inventories were produced which contain georeferenced distribution data. These data offer particularly valuable information on plant species occurrence within the province's Representative Areas Network (RAN), which is intended to conserve varied and unique landscapes of Saskatchewan[16].

Data on species distribution obtained from different sources, i.e. herbarium collections, phenological database and field surveys, often do not have the same level of accuracy[17]. This is mostly because they were collected using different approaches, i.e. the traditional *ad hoc* method versus systematic survey. Also, distribution data often were recorded before the widespread use of global positioning systems (GPS), particularly the older data in herbarium collections, and therefore in many cases cannot be georeferenced with a high level of accuracy. The combined analysis of data obtained from different sources may minimize the biases associated with each of the data sets which will eventually help to judge the biodiversity conditions to improve the quality of biodiversity assessments.

We initiated study on using multiple data sources for distribution analysis to inform biodiversity assessment by selecting the prairie crocus (*Anemone patens* L.) from the buttercup family

(Ranunculaceae) as a model species (Figure 1). This plant is a common species of native grasslands in Saskatchewan[18], which have experienced a dramatic decline as a result of changes in land use and the lack of a natural dynamic regime (e.g. grazing, fire) during the last centuries[19]. Current estimates indicate that, on average, less than 20% of the original prairie in the Central Plains remains, and only 3.5% has been protected overall within Canada. For some prairie types, the situation is critical; e.g. most of the fescue prairie in Saskatchewan was ploughed and less than 1% of the once vast area remains[19].

A. patens is a typical example of a prairie plant that has declined greatly because most of its habitat were ploughed or cultivated[20,21]. Therefore, studying distribution and range dynamics of *A. patens* can provide conservation planners with important insights into how this and other prairie plants may respond to the increasing anthropogenic impact and how to model the landscape to help assess the effects of different projects development on biodiversity. This approach will also allow expanding the current knowledge on habitat preferences of *A. patens*, as well as important features of the species ecology and biology.

Figure 1. The prairie crocus (*Anemone patens*).

METHODS

For the purposes of this study we access the freely available distribution records of *A. patens* from herbarium collections and phenological database, as well as conducted intensive field surveys. Distribution records of *A. patens* were obtained from herbarium specimens collected in the period from 1920 to 2000. In order to reduce the herbarium data gap which occurred after the year 2000, observation records from the SK PlantWatch (2001–2010) and author's field surveys (2011–2013) have been included in this study.

Herbarium data

Specimens of *A. patens* from the collections in the W.P. Fraser Herbarium of the University of Saskatchewan in Saskatoon (SASK)[22] and the G.F. Ledingham Herbarium of the University of Regina (USAS)[23] were the primary sources of herbarium data for this study. Distribution data from the National Collection of Vascular

Table 1. Records of *Anemone patens* occurrences in Saskatchewan (derived from the W.P. Fraser Herbarium of the University of Saskatchewan – SASK)

Period	No of collectors	No of specimens in SASK deposited	No of specimens in SASK analyzed*	Percentage of total
1920–1930	4	4	0	2.6
1931–1940	7	10	5	6.6
1941–1950	2	4	3	2.6
1951–1960	13	13	13	8.6
1961–1970	10	36	35	23.8
1971–1980	13	27	27	17.9
1981–1990	18	30	29	19.9
1991–2000	18	27	27	17.9
Total		154	137	100.0

Note: *Specimens were removed from analysis if they could not be georeferenced.

Plants in Agriculture and Agri-Food Canada (DAO)[24], the National Herbarium of Canada (CAN)[25] in Ottawa, and the Vascular Plant Herbarium of the University of Alberta in Edmonton (ALTA)[26] were also used in our study.

In total, 179 specimens of *A. patens* from the SASK were investigated (Table 1). Of these, 24 specimens outside of Saskatchewan and one specimen lacking location data were excluded from the analysis. Therefore, 154 records have been further analyzed. In cases where latitude and longitude were not indicated, the coordinates were estimated based on the legal survey information given in terms of quarter, section, township and meridian data or the best possible location point was estimated using the Google Earth and the Atlas of Canada reference maps[27]. Coordinates that were estimated may have inaccuracies of 5–10 km. All recorded points were mapped using Google Earth. From the preliminary selected 154 records, 17 locations could not be correctly estimated due to inadequate data on the voucher specimens and hence 137 locations of *A. patens* from SASK were identified for the distribution analysis.

The same procedure was used with respect to specimens from all herbarium collections listed above. In addition to the data gathered from the herbaria, a total of 3 records of *A. patens* specimens collected in Saskatchewan were obtained using on-line access from the Vascular Plant Herbarium of the University of Alberta[26]. Thus, finally selected 177 voucher specimens, asserted from 1920 to 2000, formed database of records from herbarium collections (137 – SASK; 31 – USAS; 6 – DAO and CAN; 3 – ALTA) for the *A. patens* distribution analysis.

Phenological data

The SK PlantWatch[15] database contains 83 georeferenced phenological observations of *A. patens* recorded by volunteers in Saskatchewan between 2001 and 2010. All recorded points were checked for accuracy and mapped using Google Earth. All recurrent points were excluded to eliminate multiple year collections at the same location (58 points). Two locations were excluded, as the plants were not growing in the wild. In this way 23 observation records from the database were selected and included in further distribution analysis.

Survey data

Field surveys to search for *A. patens* were conducted by researchers and student volunteers from the University of Saskatchewan in the six

province's ecoregions (Table 2). These field surveys were carried out at the sites with federal (2 national parks), provincial (3 provincial parks), and private (7 rangelands) land ownership. We also surveyed preserved remnants of natural grasslands within the city of Saskatoon and its vicinity, which are under municipal administration (9), managed by the Meewasin Valley Authority (8), Wanuskewin Heritage Park (1) or the University of Saskatchewan (1). Visits were made from the end of April to early June in 2011–2013. Student volunteers from the School of Environment and Sustainability at the University of Saskatchewan contributed above 150 hours to this survey effort.

Field surveys were conducted by walking. A total 288 point occurrences of *A. patens* were georeferenced in these locations using a handheld GPS unit. As a general rule, two occurrences of *A. patens* were considered to be distinct if their centers were separated by at least 100 m. In some cases the recorded large locations were an artificial representation of a population continuum. To minimize sampling bias, we identified occurrences as separate points only when they were more than 1 km apart. In this way, 74 occurrences out of 288 were selected for distribution analysis.

GIS analysis

A map depicting the distribution range of *A. patens* in Saskatchewan was prepared for the final 274 records from different data sources: herbarium collections (177), phenological database (23) and field surveys (74). Distribution of *A. patens* is shown in 325 UTM grid cells 50 x

Table 2. Geographical locations of field surveys of *Anemone patens* in Saskatchewan (n = 74 occurrences)

Survey site	Ecozone	Ecoregion
Greenwater Lake Provincial Park	Boreal Plain	Mid-Boreal Upland
Prince Albert National Park	Boreal Plain	Mid-Boreal Upland
Redberry Lake Biosphere Reserve	Prairie	Aspen Parkland
The Battlefords Provincial Park	Prairie	Aspen Parkland
City of Prince Albert	Prairie	Boreal Transition
Cypress Hills Interprovincial Park	Prairie	Cypress Upland
Grasslands National Park	Prairie	Mixed Grassland
City of Saskatoon	Prairie	Moist Mixed Grassland
Meewasin Valley Authority	Prairie	Moist Mixed Grassland
University of Saskatchewan	Prairie	Moist Mixed Grassland
Wanuskewin Heritage Park	Prairie	Moist Mixed Grassland

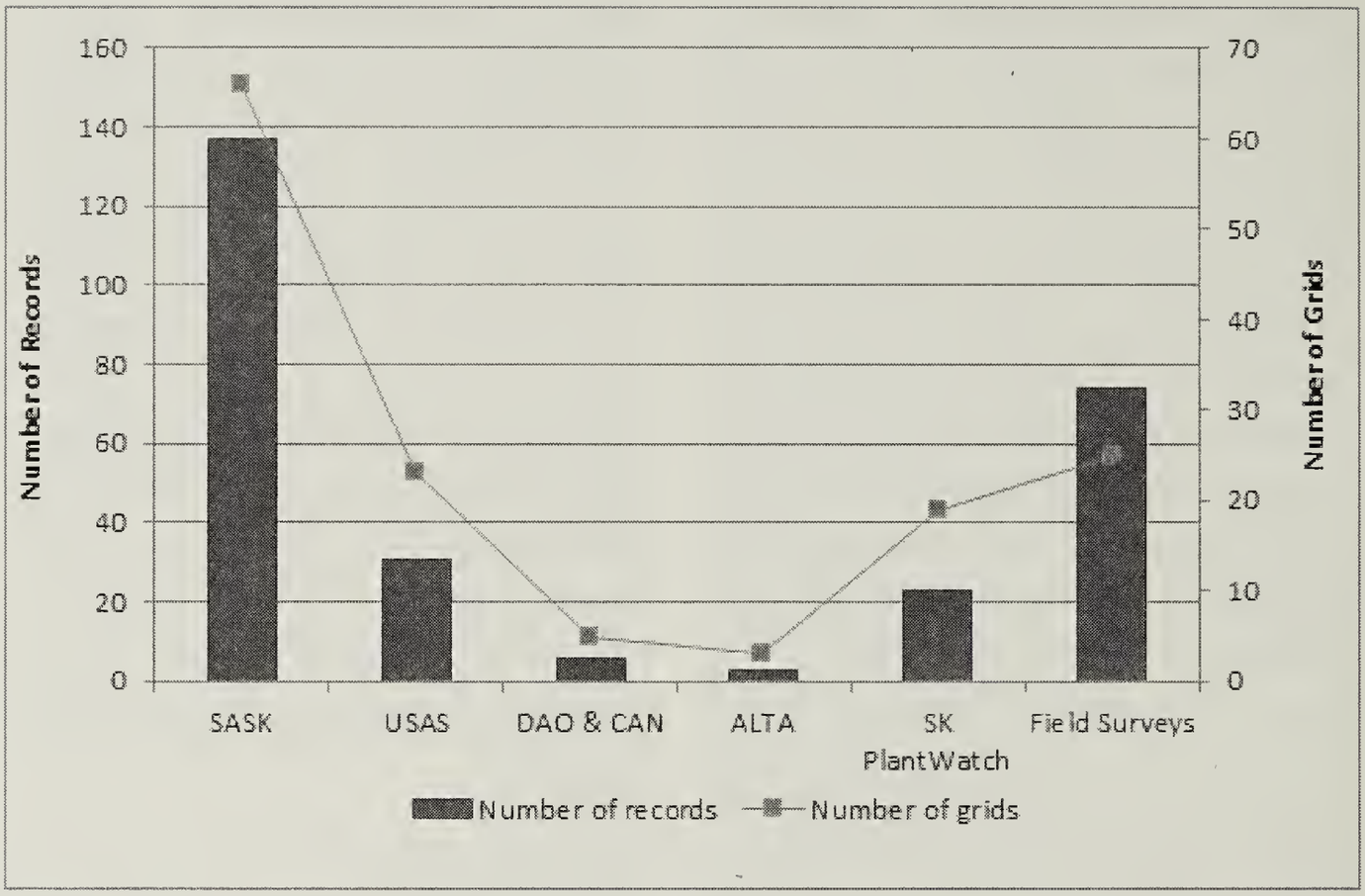

Figure 2. Collecting intensity of *Anemone patens* in Saskatchewan (location records and mapping grids): SASK – W.P. Fraser Herbarium of the University of Saskatchewan; USAS – G.F. Ledingham Herbarium of the University of Regina; DAO – National Collection of Vascular Plants in Agriculture and Agri-Food Canada; CAN – National Herbarium of Canada; ALTA – Vascular Plant Herbarium of the University of Alberta; SK PlantWatch – Saskatchewan PlantWatch phenological database; Field surveys – author's vegetation relevés.

50 km (Table 3). This approach is in accordance with plant distribution maps for other parts of the world.

We developed ArcGIS layers using data from different sources and plotted *A. patens* occurrences. To analyze the *A. patens* habitat associations across the range, the following GIS layers were considered: topography, ecological systems (ecozone, ecoregion and ecodistrict), climate (precipitation, temperature and climate moisture index), soils, land cover, and protected area. The ecological systems layer is a subset of the National Ecological Framework for Canada, which is designed in a nested hierarchy of ecozones, ecoregions, and ecodistrict, all these 3 layers were acquired from AAFC website[28], and analyzed in this paper.

Table 3. Records of *Anemone patens* occurrences in mapping grids 50 x 50 km in Saskatchewan (derived from different data sources)

Data source	# records	% total	# grids	% total	# new grids	% total	accumulated # new grids	% total
SASK	137	50.0	66	46.8	66	67.3	66	67.3
USAS	31	11.3	23	16.3	10	10.2	76	77.6
DAO & CAN	6	2.2	5	3.5	5	5.1	81	82.7
ALTA	3	1.1	3	2.1	0	0.0	81	82.7
SK PlantWatch	23	8.4	19	13.5	6	6.1	87	88.8
Field surveys	74	27.0	25	17.7	11	11.2	98	100.0
Total	274	100.0	141	100.0	98	100.0	98	100.0

Note: SASK – W.P. Fraser Herbarium of the University of Saskatchewan; USAS – G.F. Ledingham Herbarium of the University of Regina; DAO – National Collection of Vascular Plants in Agriculture and Agri-Food Canada; CAN – National Herbarium of Canada; ALTA – Vascular Plant Herbarium of the University of Alberta; SK PlantWatch – Saskatchewan PlantWatch phenological database; Field surveys – author's vegetation relevés.

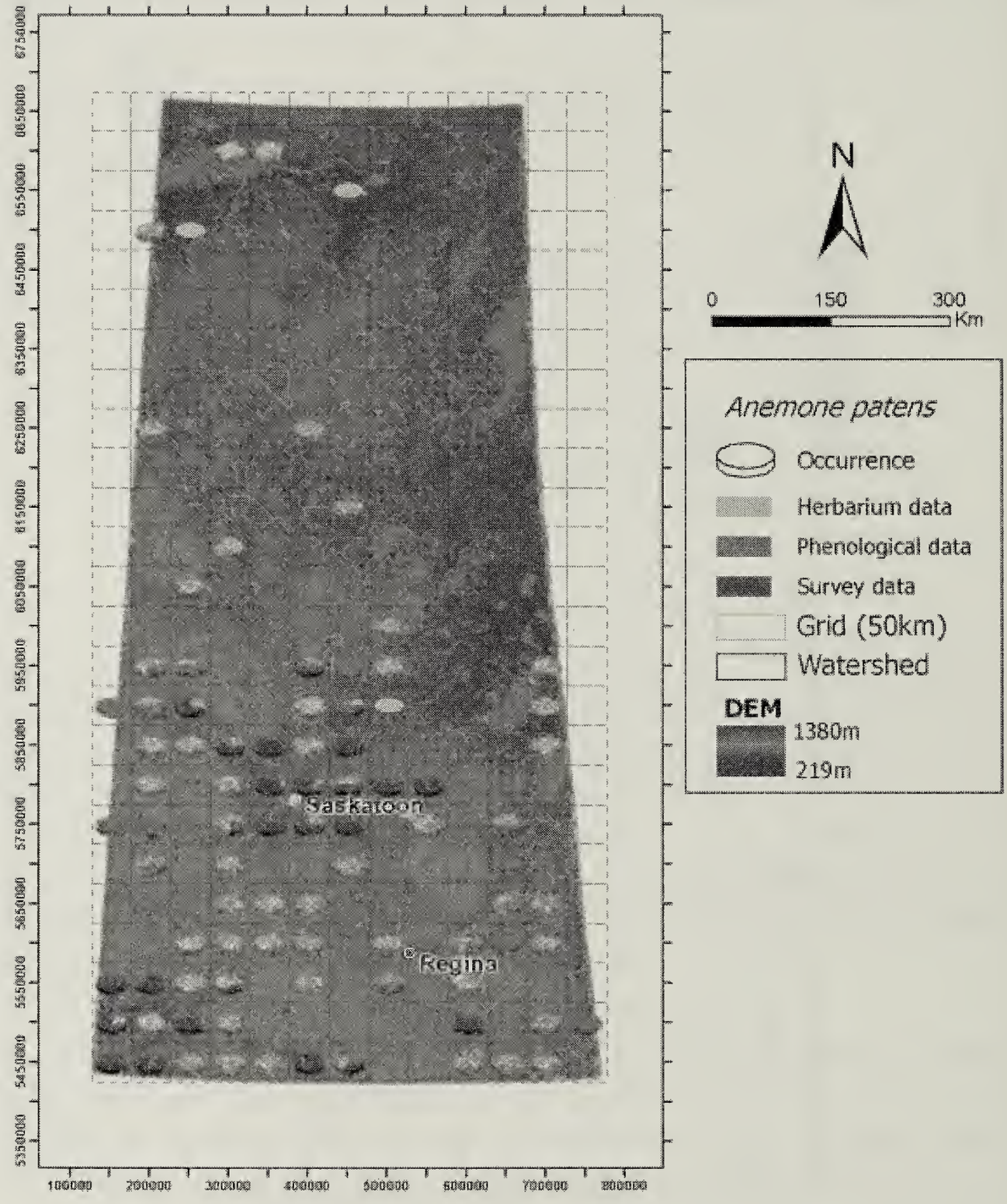

Figure 3. Distribution of *Anemone patens* in Saskatchewan.

The digital elevation model (DEM) layer at the scale of 1:250,000 was derived from GeoBase website in ASCII format and is part of the Canadian Digital Elevation Data[29]. To cover the whole territory of the province, 54 sliced tiles of the DEM layer were downloaded, mosaicked and clipped in this study. The land cover layer was acquired from the Geogratis website in vector format, at the scale of approximately 1:2,000,000 from

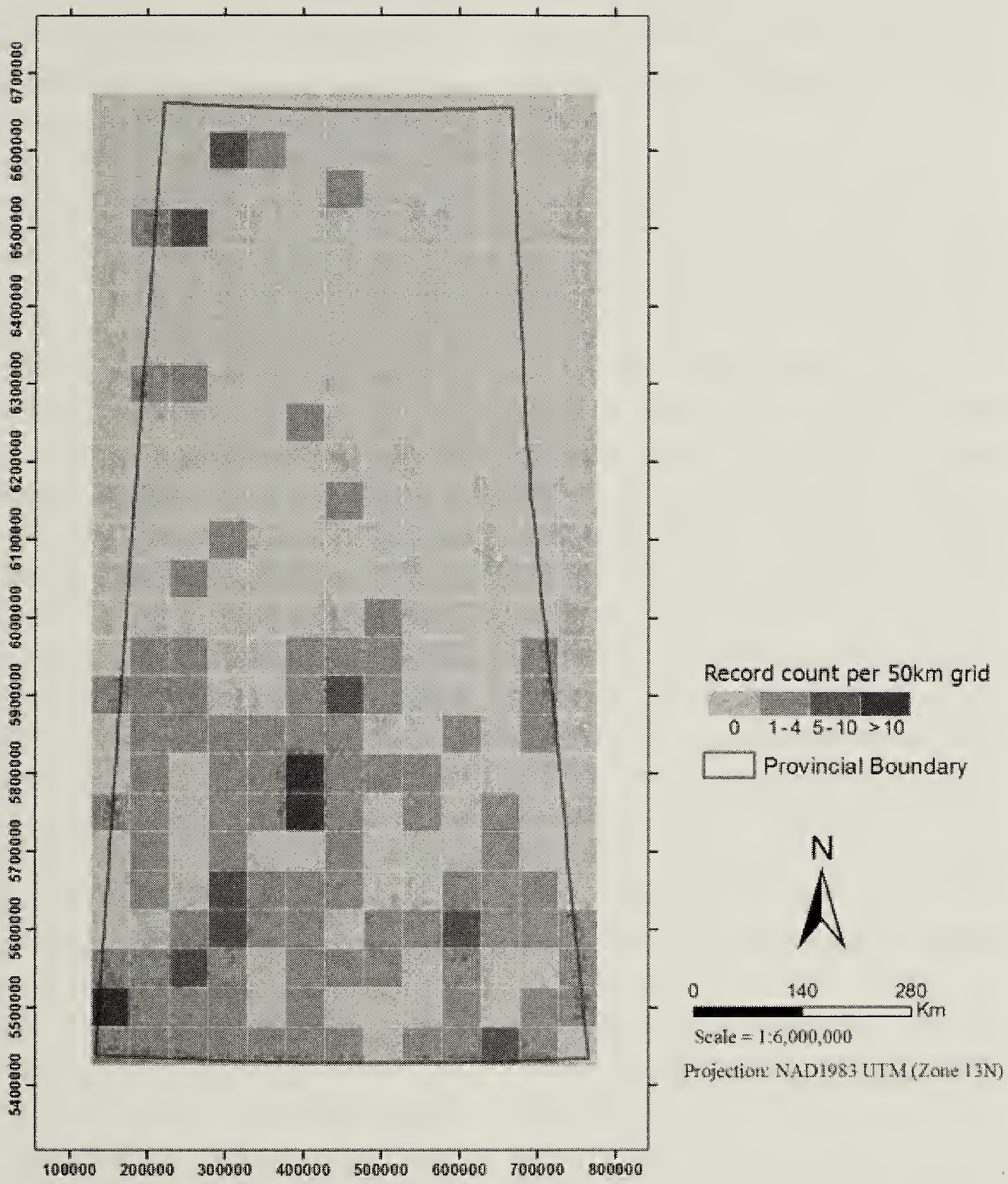

Figure 4. Density of *Anemone patens* in Saskatchewan (number of locations per 50 x 50 km mapping grid).

AVHRR Land Cover Data[30]. We also evaluated other land cover data products with much higher spatial resolutions. For example, the Land Cover Data vector layer (circa 2000) generated from Landsat TM5/7 images is available at the scale of 1:250,000[31]. However, the purpose of this study was to investigate the distribution of *A. patens* in the provincial scale, which covers

652,000 km^2 makes the coarser resolution more effective than the finer dataset (33 vector layers with around 1G filesize) in the analysis.

For the climate layers, annual precipitation and annual mean temperature were acquired from the WorldClim website (version 1.4, release 3) in Geotiff format at the spatial resolution of 30 arc–seconds[32]. Original data were published in the DBase format, which was linked to the ecodistrict layer. Climate Moisture Index (CMI) data were calculated following Hogg's method[33] by subtracting annual potential evapotranspiration (PET) from annual precipitation (P). Both P and PET (prepared using Thornthwaite Method) were acquired from the Agriculture and Agri–Food Canada website[34]. CMI was linked to the ecodistrict layer.

The soil order layer was derived from Soil Landscapes of Canada (SLC) version 3.1 for agricultural areas and SLC version 2.2 and 1.0 for non–agricultural areas[35]. There were in total 9 soil orders identified within the province. The protected area layers were derived (500 m buffer is used as the threshold for this assessment to factor in errors in data quality) from the Atlas of Canada 1,000,000 National Frameworks Data, Hydrology version 6[36].

RESULTS

Distribution

A. patens is registered in 98 UTM grid cells established for Saskatchewan which accounts for more than one-quarter (30.2%) of all mapping units (325 UTM grid cells) for the province. Herbarium collections (SASK, USAS, DAO, CAN, and ALTA) are a primary source of data (177 points or 64.6%), while observations from phenological database (23 points or 8.4%) and vegetation relevés from field surveys (74 points or 27.0%) together account for one-third of all records (97 points or 35.4%) (Figure 2). In terms of new (actual) mapping grids, this difference is more substantial: herbarium data accounts for most of the units (81 grids or 82.7%), while phenology database (6 grids or 6.1%) and field surveys (11 grids or 11.2%) together contributes only 17 grids or 17.3% of new mapping units.

Range extent

The species is commonly found in the southern part of the province, but it extends north to Uranium City and Cluff Lake. The species' range map reveals the distribution patterns of *A. patens* (Figure 3), i.e. the number of *A. patens* locations gradually decreases as we move from south to north and from west to east (Figure 4). The most locations are

observed in the area lying between Saskatoon (52.5°N, 106.5°W) and Swift Current (50.2°N, 107.5°W), which represents the center of the *A. patens* latitudinal range in Saskatchewan and roughly overlaps with the northern and southern boundaries of the Prairie ecozone. No species' locations identified in this study were recorded in northeastern Saskatchewan.

Range trend

Almost three-quarters (72.6%) of recorded *A. patens* locations are concentrated in areas dominated by agricultural croplands (49.3%) and rangelands (23.4%), which makes their persistence vulnerable to intensification of agricultural practices. The rest of the locations (18.3%) are scattered across forests (transitional, coniferous, mixed, and deciduous) and also found in built–up areas (9.1%). During our field surveys, we determined that several *A. patens* locations (7 or 2.6% of total occurrences) have gone extinct over the 20th century. Out of all recorded locations of *A. patens*, only 44 (16.1%) are found in protected areas within the Saskatchewan's Representative Area Network (RAN).

Habitat affinities

Ecological communities

Most *A. patens* locations (79.9% of total occurrences) were found in the Prairie ecozone. They are allocated within different ecoregions of this zone in the following way: the Moist Mixed Grassland (44.7%), Mixed Grassland (27.9%), Aspen Parkland (20.1%) and Cypress Upland (7.3%). Generally, the number of *A. patens* locations gradually decreases from the Prairie ecozone to the Taiga Shield ecozone. Within the Boreal Plain ecozone (13.5% of total occurrences) the majority of locations are found in the Boreal Transition ecoregion (51.4%) and the Mid–Boreal Upland ecoregion (45.9%). In the Boreal Shield ecozone (4.0% of total occurrences) the richest ecoregion is the Athabasca Plain (72.7%). All the records in the Taiga Shield ecozone (2.6% of total occurrences) have been collected in the Tazin Lake Upland ecoregion. There are records in the northwest, indicating that latitude is not a limiting factor.

Soils

A. patens occurs on soils that belong to the Chernozemic soil order (69.3% of total occurrences). These soils developed under semi–arid to semi–humid grassland conditions. The pH range for these soils is from about 6.6 to 7.2. However, many locations of *A. patens*

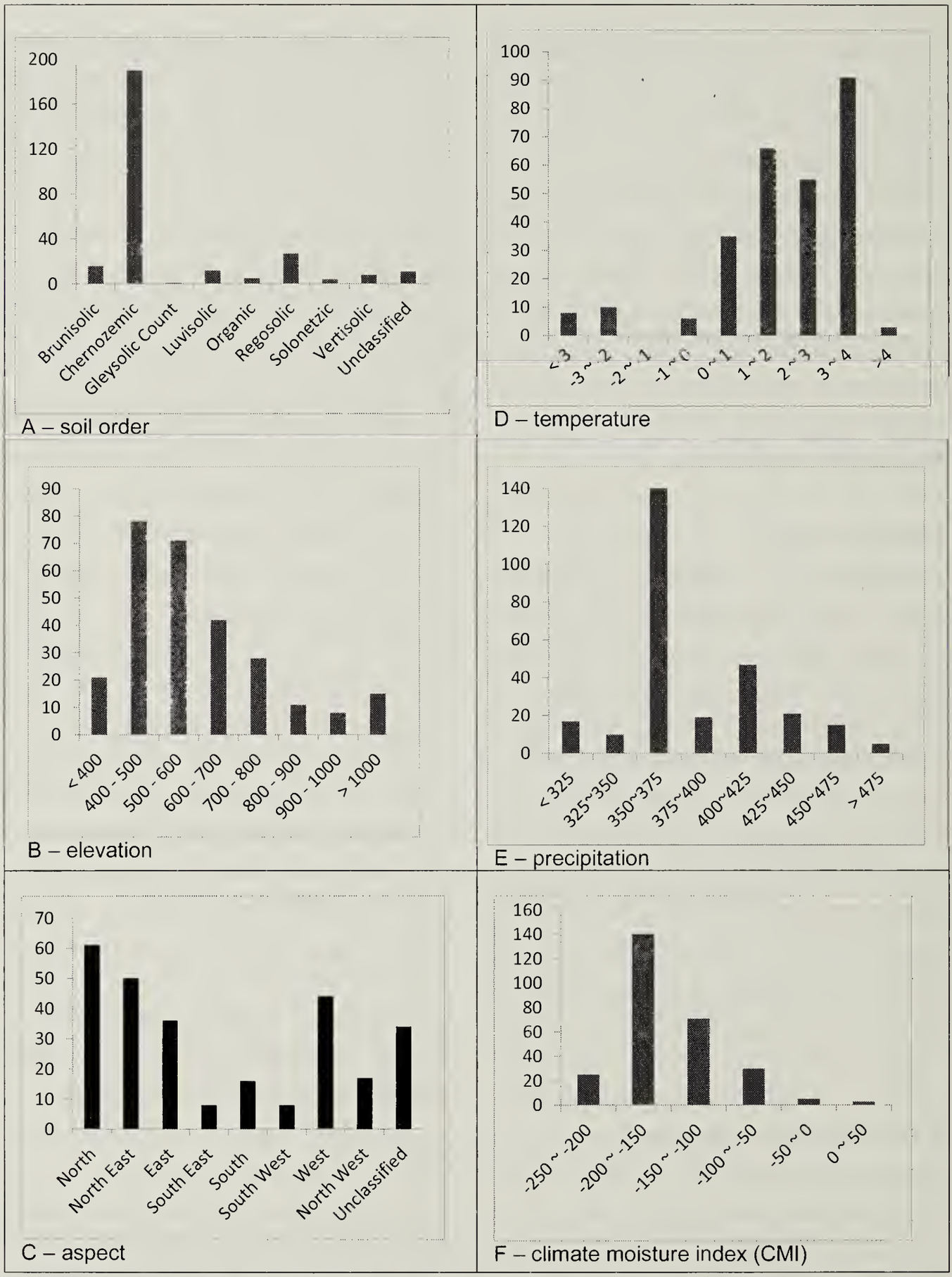

Figure 5. Habitat affinities of *Anemone patens* in Saskatchewan with regards to key ecological factors: in all figures on the vertical axes – number of records, on the horizontal axes – factor's value.

(26.7%) are found on well drained, sometimes sandy soils in the other seven soil orders, namely Brunisolic, Gleysolic, Luvisolic, Organic, Regosolic, Solonetzic, and Vertisolic. The small number

of remaining locations (4.0%) is unclassified (Figure 5A).

Topography

Majority of *A. patens* locations (79.2% of total occurrences) are registered within altitudinal zone 400–800 m a.s.l. (Figure 5B). A small part of the range (7.7% of total occurrences) is confined to the lowland conditions in the Boreal Shield ecozone at elevations from 200 to 400 m a.s.l. The lowest occurrence point found is of 233 m a.s.l. which is located near Lake Athabasca in the vicinity of Uranium City. Some locations (12.4% of total occurrences) are found in altitudinal zone from 800 to 1300 m a.s.l. in the occasionally rising upland areas of the Mixed Grassland, Aspen Parkland and Cypress Upland. Only seven locations lie above 1200 m a.s.l. and the highest occurrence point recorded is of 1315 m a.s.l. in the Cypress Upland where a clear shift towards mountain habitats is visible.

Regarding the aspect of the recorded locations, almost half of them faced north and northeast. A proportion of 13.27% faced east, 15.93% eest and 6.19% northwest. South, southeast and southwest facing locations together accounted for less than 12%. These identified patterns are illustrated in Figure 5C, where the sites facing more than one direction have been counted multiple times, one for each of the faced directions. A total of 12.30% of the locations lacked any aspect.

Precipitation

Saskatchewan receives about 250–550 mm of precipitation in the form of rain or snow annually[31]. About three-quarters of *A. patens* locations (75.2% of total occurrences) lie in the region receiving 350–425 mm of precipitation annually (Figure 5D). Slightly above half of locations (51.1%) are found in a region that receives 350–375 mm of precipitation annually. *A. patens* has not been recorded in areas with either very low (< 325 mm) or high (> 475 mm) precipitation.

Temperature

Annual mean temperature in Saskatchewan ranges from -7.5°C to +6.5°C (Hijmans et al., 2005). According to our analysis, overall *A. patens* most commonly grows in the areas with positive annual temperatures ranging from > 0°C to < 4°C (90.1% of total occurrences) (Figure 5E).

Climate moisture index

Our analysis show that the annual climate moisture index (CMI), which was computed by subtracting annual potential evapotranspiration (PET) from

annual precipitation (P), in Saskatchewan ranges from -249 to 6. According to our analysis, 97.1% of total occurrences lie in the region having CMI of -250 to -50. The maximum number of locations (51.1%) are found in the region having CMI between -200 to -150, 25.9% fall between -150 to -100 and 10.9% between -100 to -50 (Figure 5F). The species seems to avoid areas with an excess of precipitation over evaporation – 98.9% of total occurrences lie in the regions having negative CMI.

DISCUSSION

In terms of herbarium data contribution to distribution analysis of *A. patens*, both major regional collections located in Saskatchewan (SASK and USAS) provided a substantially higher number of specimens (94.9%) and accounts for the majority of mapping grids (93.8%) compare to data collected from larger national herbaria (DAO and CAN). Herbarium specimens found in DAO and CAN are almost all duplicates (93.6%) of the specimens deposited at SASK and USAS. The accuracy of information on the species location retrieved from the analyzed herbarium data is rather high, i.e. 89.0% of all deposited specimens in SASK and 90.5% in USAS respectively have been successfully georeferenced and used for further distribution analysis.

In order to reduce the herbarium data gap which occurred after the year 2000, phenological observations from the SK PlantWatch (2001–2010) and vegetation relevés from the author's field surveys (2011–2013) have been included in this study. Employing data obtained from these sources improved the quality of *A. patens* range assessment by adding about one-third of new locations (97 records or 35.4% of total occurrences) to the distribution analysis. In terms of mapped grid cells 50 x 50 km, these records account for 17 new units (17.3% of total) on the species distribution map in Saskatchewan.

The quality of the analyzed information collected from phenological database and field surveys is dramatically different. While all vegetation relevés were properly georeferenced and documented, there were problems with phenological records (multiple year collections at the same location or inaccurate data), hence only about one-quarter of these data (27.7%) was used for distribution analysis. Data entry mistakes and challenges with georeferencing call for rather cautious approach in using

computerized databases because it may potentially misinform biodiversity assessment and conservation practices. This is in line with other studies[37] which have revealed that georeferencing errors can cause an overestimation of the area occupied by a species, make impossible to predict a species range dynamics under global warming scenarios or identify geographically invalid locations.

The data obtained from this analysis expanded the current knowledge of biology and ecology of *A. patens*. Applying GIS analysis, the habitat affinities of *A. patens*, including the species relationships to ecological communities, soils, topography, land use, precipitation, temperature, and the climate moisture index were explicitly characterized. This analysis demonstrates that in North America, *A. patens* is a more western species, mainly of the northern Great Plains. It was revealed that *A. patens* is widely distributed in Saskatchewan and that the Prairie ecozone represents the center of the current species range in the province. Although common in all types of prairies it seems to be especially linked with the endangered fescue prairie[38].

Historically *A. patens* was everywhere on the prairies, particularly in Saskatchewan[39]. Currently, a major part the entire Prairie ecozone is converted to croplands and rangelands with remaining lands being used for urban development, roads and highways, rail roads, mining sites, oil and gas production[40]. During last century *A. patens* has been lost due to cultivation, urbanization, industrial areas, and infrastructure and it is now relatively uncommon in and around major cities in Saskatchewan[41]. This range contraction can be mostly attributed to direct habitat loss and fragmentation.

Most recently, a population study of *A. patens* for monitoring its conservation status in Saskatchewan has been initiated[21]. Because range contraction and habitat fragmentation is threatening not only the rarest plants, studying their effects on still abundant species is of scientific and conservation interest[42,43]. There are many documented examples of previously common species that are now listed as threatened with extinction[43], indicating that rapid change of a common species to rare one often occurs. A good illustration of this process might be the fate of *A. patens* in Europe. During the past few decades *A. patens*

is dramatically declining across the entire continent and hence the species has recently been legally protected in the majority of European countries where it naturally occurs[21].

Habitat information can also be useful for directing landscape level search for some prairie vegetation communities for which *A. patens* shows a high fidelity. Additionally, the suggested approach may contribute to development of Flora of Saskatchewan and other related projects. Moreover, this approach has potential to enhance such series as Biological Flora of the Canadian Prairie Provinces[44] and Biological Flora of Canada[45], should they be renewed in the future.

This approach can also be transferred to other species in Saskatchewan, particularly focusing on distribution of native plants under the impact of habitat loss and fragmentation, contributing to different biodiversity assessment at different spatial and temporal scales. It may also improve our understanding of species range dynamics in a rapidly changing world. The suggested approach demonstrates how to combine traditional herbarium collections and field surveys with modern technologies (GIS, GPS, and online databases) to map species distribution and analyze their habitats.

We hope that suggested approach will also encourage amateur naturalists and volunteers to collect base inventory data and assist in monitoring activities through mapping species distribution which could be an effective method of documenting land use and conducting different exercises for community planning. While voluntary participation in citizen science is not new, we see our approach as a mean to involve the public in environmental management, which can foster community stewardship and public support for necessary actions. It will be well worth the effort, a new dawn for citizen science.

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BIRDS

AVIAN BIODIVERSITY IN AN URBAN PARK: BREEDING BIRDS OF THE HABITAT CONSERVATION AREA (2010-2014)

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INTRODUCTION

Since the establishment of the Wascana Game Preserve in 1913, habitat within Wascana Centre, a 930 hectare urban park, and around the City of Regina has changed significantly, from a treeless prairie to an urban forest surrounded by cropland. Many grassland songbird species such as the Western Meadowlark (*Sternella neglecta*), Say's Phoebe (*Sayornis saya*), McCown's (*Calcarius mccownii*) and Chestnut-collared Longspur (*Calcarius ornatus*), were once described as common summer residents, but are now rare or absent from the Regina area (Belcher 1980). Documenting the current avian biodiversity with the changes in habitat and climate is important.

The Habitat Conservation Area (HCA) within Wascana Centre, is a 9.3 ha piece of land that has been set aside for wildlife within the park. The HCA is a mixture of tame grassland, shrubs and tree rows, which is bordered to the south and east by cattail, bulrush, willow marsh, along Wascana Creek. In 2010, the Wascana Monitoring Avian Productivity and Survivorship (MAPS) station was established in the HCA to monitor the local bird community.

Clarke and Ewart (2010) compared the first year of results from the MAPS station to a survey by Donison (1976) and found 19 species that had been found to breed in and around the HCA in 1975, were absent in 2010.

To further document current avian biodiversity and the importance of this area to birds, we initiated an opportunistic nest searching program in 2013-14. Here we report results from our MAPS observations (2010-2014) as well as the nest searching we conducted (2013-2014).

METHODS

MAPS 2010-2014 Breeding Status

As part of the MAPS protocol all birds observed during banding operations are recorded along

with their behaviour. Birds must be observed within 100 m of one of the MAPS mist nets to be included therefore the entire area of the HCA is not covered. Breeding status was assigned as *Confirmed*, if a current nest was found, a bird was seen carrying nesting material or food, performed a distraction display or a just fledged bird was observed. Breeding was *Probable* if singing, courtship/copulation or territorial behaviour was observed. If the bird was seen flying over the HCA, was banded or seen without exhibiting any of the territorial or breeding behaviours above it was recorded as *Observed*. At the end of the season, year status was assigned as Breeder, Likely Breeder, Transient, or Migrant. Species were then determined to be Regular Breeders (if believed to have bred every year), Usual Breeders (if >1/2 but not all, years), Occasional Breeder (<1/2 years), Transient (T; if not believed to have bred within the MAPS site), or Migrant (M; species not believe to breed in area).

Nest searching 2013-2014

Nest searching occurred opportunistically through the summer (May-August, 2013-2014). GPS locations, species, clutch or brood size, and vegetation structure around the nest were documented. Due to the relatively high human presence in such a small area, we did not revisit nests regularly (particularly ground nests), unless it was easy to observe the nest without disturbing the birds (i.e. using binoculars from the path to confirm presence of chicks, etc). On June 24th, 2013 and July 17, 2014 we used a 20 m long drag rope to search for ground nesting species in the grass and marsh edge areas of the HCA. We did not search the cattail and bulrush dominated marsh along the southwest and west side of the HCA in either 2013 or 2014, nor did we search the tree/shrub rows on the east portion of the HCA in 2013.

RESULTS

MAPS 2010-2014 Breeding Status

During the Wascana MAPS program, 99 species of birds were observed in the HCA between June 10 and August 10, 2010-2014. Forty of these species were suspected or confirmed to breed in and around the HCA in at least one year (Table 1). Twenty four species were classified as Regular breeders, 7 species were usual breeders, and an additional 9 were Occasional breeders (see Table 1).

Nest searching 2013-2014

We located 118 nests in 2013-2014. In 2013, 55 nests of 20 species were located (5.9 nests/ hectare; Figure 1) and 63 nests of

Table 1. Based on observations during the Wascana MAPS program (2010-2014), species breeding status was assessed for each year as a Confirmed Breeder (B), Likely Breeder (LB), Transient (T), or not recorded (-). Species were assigned a cumulative Breeding Status, if they breed within the Wascana MAPS site every year (Breeder, B), >1/2 of all years, but not all (Occasional Breeder, O), or <1/2 of all years (Unusual Breeder, U). The total number of nests located by nest searching in 2013 and 2014 is also presented. *Brown-headed Cowbird nests were those of other birds with cowbird eggs present.

		Wascana MAPS Breeding Status						Nest searching	
Species	4-letter code	2010	2011	2012	2013	2014	Cumulative Breeding Status	Total nests 2013	Total nests 2014
American Goldfinch	AMGO	B	B	B	B	B	**B**	3	3
American Robin	AMRO	B	B	B	B	B	**B**	2	2
American Wigeon	AMWI	B	B	B	B	B	**B**	1	1
Brown Thrasher	BRTH	B	B	B	B	B	**B**	0	0
Brown-headed Cowbird	BHCO	B	B	B	B	B	**B**	4	6
Canada Goose	CANG	L	B	B	B	L	**B**	1	0
Cedar Waxwing	CEDW	B	B	B	B	B	**B**	4	10
Clay-coloured Sparrow	CCSP	B	B	B	B	B	**B**	3	7
Common Grackle	COGR	B	B	L	B	L	**B**	1	1
Common Yellowthroat	COYE	B	B	B	B	B	**B**	2	0
Eastern Kingbird	EAKI	B	B	B	B	B	**B**	3	2
Gray Catbird	GRCA	B	B	B	B	B	**B**	3	2
House Wren	HOWR	B	L	B	B	B	**B**	0	0
Least Flycatcher	LEFL	B	B	B	B	B	**B**	0	1
Mallard	MALL	B	B	B	B	B	**B**	8	5
Mourning Dove	MODO	L	L	B	B	B	**B**	5	4
Northern Flicker	NOFL	B	B	L	L	L	**B**	0	0
Red-winged Blackbird	RWBL	B	B	B	B	B	**B**	5	2
Song Sparrow	SOSP	B	B	B	B	B	**B**	0	0
Sora	SORA	B	B	B	L	B	**B**	0	0
Tree Swallow	TRES	L	B	L	L	L	**B**	0	0
Warbling Vireo	WAVI	L	B	B	B	B	**B**	0	0
Western Kingbird	WEKI	B	B	B	B	B	**B**	2	1
Yellow Warbler	YEWA	B	B	B	B	B	**B**	7	16
Baltimore Oriole	BAOR	-	B	B	B	B	**U**	1	1
Blue-winged Teal	BWTE	T	B	B	B	L	**U**	1	0
Gadwall	GADW	B	B	T	B	B	**U**	1	2
House Finch	HOFI	-	L	T	L	L	**U**	0	0
Marsh Wren	MAWR	B	L	B	B	-	**U**	0	0
Nelson's Sparrow	NESP	L	-	-	B	B	**U**	0	1
Yellow-headed	YHBL	B	B	T	B	-	**U**	1	0

19 species were located in 2014 (6.7 nests/hectare; Figure 2). The four most common nests located were those of Yellow Warbler (n=23; *Dendroica petechia*), Cedar Waxwing (n=14; *Bombycilla cedrorum*), Mallard (n=7; *Anas platyrhynchos*) and Clay-colored Sparrow (n=9; *Spizella pallida*). Interestingly, Yellow Warbler and Cedar Waxwing were also the species most commonly caught as part of the MAPS program.

Comparison between MAPS results and nest searching

We located nests of 17 of 24 Regular breeders (71%), 5 of 7

Usual breeders (72%) and 2 of 9 Occasional breeders (22%). Of the Regular breeders we did not locate nests of Brown Thrasher (*Toxostoma rufum*), House Wren (*Troglodytes aedon*), Northern Flicker (*Colaptes auratus*), Song Sparrow (*Melospiza melodia*), Sora (*Porzana carolina*), Tree Swallow (*Tachycineta bicolor*) or Warbling Vireo (*Vireo gilvus*).

Brown-headed Cowbird Parasitism

Brown-headed Cowbirds (*Molothrus ater*) had laid eggs in the nests of four different species in 2013 and 2014: Common Yellowthroat (n=2; *Geothlypis trichas*), Yellow Warbler (n=6), American Goldfinch (n=1; *Carduelis tristis*) and Clay-colored Sparrow (n=1). We were not able to check all nests to provide complete data on the frequency of parasitism.

DISCUSSION

Our nest searching and MAPS results show that the Habitat Conservation Area provides suitable nesting habitat for a variety of birds, despite not being native prairie. Despite relatively large numbers of birds banded as part of the MAPS program, we were surprised by the high density of nests in both 2013 and 2014 (5.9 and 6.7 nests/hectare, respectively). These values are still likely an underrepresentation of the true nest density (particularly for species like Red-winged Blackbird), as we did not search the entire study area or throughout the nesting season. For example, we did not survey the marsh areas or the heavily treed shrub rows in 2013 (Fig. 1). As a result of the differences in nest searching between years, it is difficult to make any comparisons between years.

In Clarke and Ewart (2010) a comparison between the first year of MAPS and a survey in 1975 (Donison 1976) found 19 species were absent in 2010 that were confirmed breeding in Wascana Park in 1975. Over the following four years we observed 11 of those species in the HCA although none of the observations suggested they were breeding in the area as they had been in 1975. The remaining 8 species were still absent. These included Green-winged Teal (*Anas crecca)*, Redhead (*Aythya americana)*, American Bittern (*Botaurus lentiginsous)*, Wilson's phalarope (*Phalaropus tricolor)*, Loggerhead Shrike (*Lanius ludovicianus)*, Horned Lark *(Eremophila alpestris)*, European Starling (*Sturnus vulgaris)*, and Vesper Sparrow (*Pooecetes gramineus)*.

Noteworthy nests include a single Sedge Wren (*Cistothorus*

Figure 1. The Habitat Conservation Area (HCA), within Wascana Centre, showing approximate nest locations of55 nests found between May - August, 2013. Species are listed by their 4 letter code. All nests are within the HCA fence, except for the BAOR, WEKI, and YEWA nest on the bottom right portion of the map. Note the BOBO nest was located in 2012.

platensis) nest located on June 24, 2013. It was an enclosed nest, constructed from Smooth Brome Grass (*Bromus inermis*), and supported by a Western Snowberry (*Symphoricarpos*

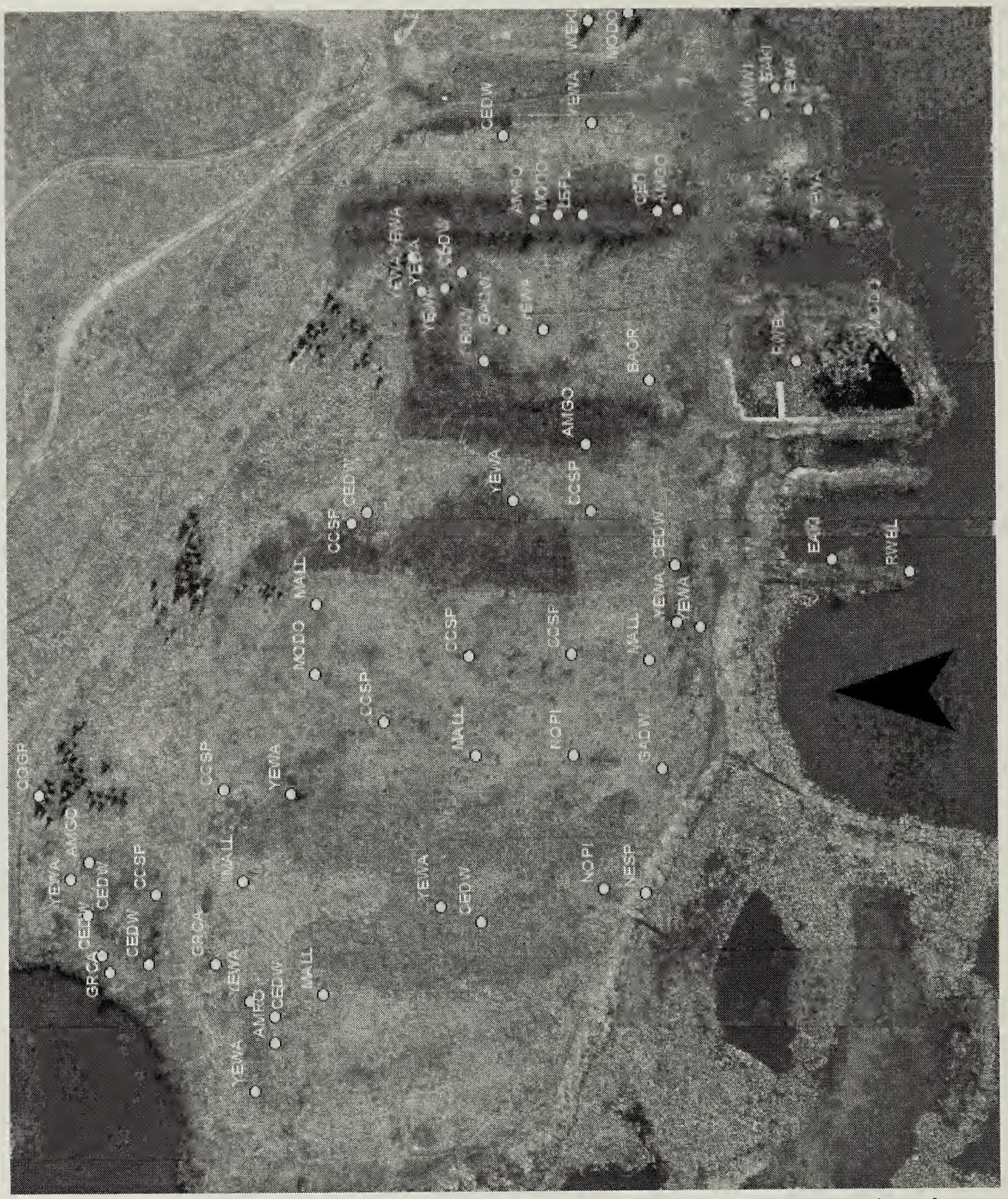

Figure 2. Approximate nest locations in the Habitat Conservation Area (HCA) within Wascana Centre, for the 63 nests found between May - August, 2014. Species are listed by their 4 letter code. All nests are within the HCA fence, except for the WEKI, MODO, EAKI and YEWA nest on the bottom right portion of the map.

occidentalis) twig. It contained five white eggs. We do not know the outcome as we did not revisit the nest. In 2013, at least five male sedge wrens were heard singing in the HCA. No sedge

Clay-colored Sparrow nest with three eggs, constructed on a Western Snowberry stem, in the Habitat Conservation Area in June 2013.

wrens were heard in 2010, 2011, or 2014.

We found nine Mourning Dove (*Zenaida macroura*) nests, two of them on the ground. In 2013, a nest with two half-grown young was located beneath an Absinth (*Artemisia absinthium)* plant, while in 2014 two eggs were found at the base of a small Prickly Rose (*Rosa acicularis*) stem and some snowberry. The outcome of these nests is not known.

Lastly, in 2012, prior to our broad scale nest searching, we located a Bobolink (*Dolichonyx oryzivorus*) nest containing five young (fig. 1).We observed one newly-fledged Bobolink chick with an adult in 2013 confirming breeding in the area. Bobolinks were absent in 2010, 2011, 2014.

These records are of particular interest given the Bobolink's listing as Threatened by the Committee of the Status of Endangered Wildlife in Canada (COSEWIC).

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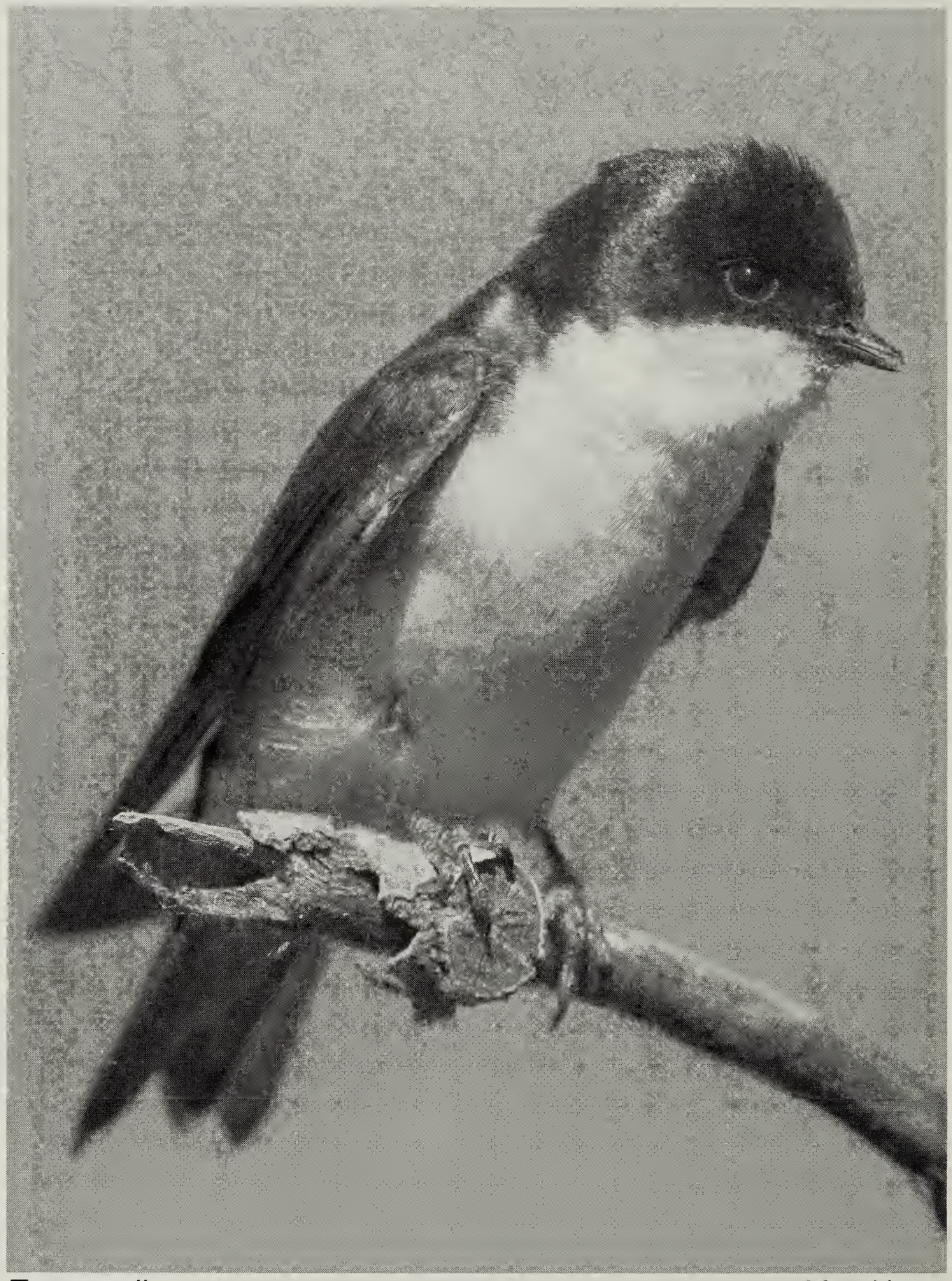
Common Yellowthroat nest in the Habitat Conservation Area, within Wascana Centre, with two Brown-headed Cowbird chicks, June 2013.

Least flycatcher nest with young *-Jared Clarke*



Tree swallow *- May Haga*

FREQUENCY OF NEST VISITS BY NON-RESIDENT HATCH-YEAR TREE SWALLOWS

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Introduction

Stiles and Taylor report on a number of instances of recently fledged tree swallows (*Tachycineta bicolor*) being detected visiting nest boxes from which they did not originate.[1] Such encounters with "non-resident" hatch-year (HY) swallows appear to be rare, but it is unclear how often such visits actually occur. The account by Stiles and Taylor[1] prompted me to examine my own records of the nesting biology of tree swallows, as well as review some of the literature, to gain further insight into the frequency of occurrence and some of the potential explanations for this phenomenon.

Study Area and Methods

I have been intensively studying tree swallows breeding in nest boxes on 3 separate study areas in the vicinity of Prince George BC (53° N, 122° W) since 2001. The Dykes area ("D") is located approximately 20 km south of Prince George and has been monitored since 2001, with the number of boxes ranging from 104 – 197 over these years. Occupancy has averaged 48.2%. The Stewards area ("S") is 20 km west of Prince George, and has been active since 2002, with the number of boxes ranging from 139 – 169 and occupancy averaging 46.4%. The Western ("W") area was established in 2008, with boxes numbers ranging between 55 – 60 and an occupancy rate of 74.9%. The Western area is approximately 10km west of Prince George.

Each study site consisted mainly of pasture and hayfields with a number of small wetlands, surrounded by second-growth forest of various ages. Nest boxes on each site were ~30 m apart and mounted either on wooden or metal fence posts in a linear fashion along roads, trails, and fence lines. Tree swallows arrived on sites in late April or early May and began laying eggs in mid- to late-May. We visited nest boxes

every other day beginning in mid-May, keeping track of the nest building progress until the first egg was laid. From then on all nests were visited daily until laying was complete, and we recorded the clutch initiation date and clutch size. Nests were then not visited again until several days before the predicted hatching date, and we subsequently documented the actual date of hatching and number of eggs hatched. In general, individual nestlings were uniquely marked with non-toxic markers beginning at 4 days of age, and banded with aluminum bands at 16 days of age. Measurements of mass and length of the combined head and bill were recorded for each nestling every other day from 4 to 16 days old. Additionally, the length of the ninth primary flight feather was measured every other day when nestlings were 8 to 16 days old. Over the course of 13 years, my students and I have made 10,238 visits to nest boxes to measure offspring growth. Nests were not visited again until 22 days post-hatch to determine fledging success.

Results

Encounters With Live Birds: On 28 July 2001, an unbanded HY tree swallow was found in box 8-D at 09:42 h and banded (3111-57942). The box contained four resident nestlings that were 12 days old. In 2004, a nestling hatched on 11 June in box 345-D, and was last measured and banded (1851-05862) on 27 June when 16 days old. On 4 July 2004 at 10:01 h it was found in box 16-D, a distance of 890m away, which contained six resident nestlings that were 16 days old. Then on the same day it was found in box 319-D at 13:29 h. Box 319-D contained seven resident nestlings that were 16 days old, and is 230m from box 16-D and 785m from box 345-D. Neither of the above two birds were recaptured in subsequent years. Most recently, on 10 July 2013 at 12:23 h an unbanded HY tree swallow was found in box 49-W. This nest contained a brood of five young that were 16 days old when the HY bird was detected.

Encounters With Dead Birds: Nestling 2321-96378 was banded at 16 days of age in box 21-D on 26 June 2010. It was later found dead in box 17-D on 5 July 2010, about 80m away. At this point the resident chicks in box 17-D would have fledged within the previous 1-2 days. Nestling 1921-13125 was banded as a day 16 nestling on 2 July 2004 at box 12-S, and was later found dead 1.0km away in box 62-S on 11 July 2004, which contained four resident nestlings that were 16 days old. We banded nestling 2321-95477 at box 12-S

on 28 June 2010 when it was 16 days old. It was found dead in box 62-S on 4 July 2010. Box 62-S contained seven chicks on 4 July that were 12 days old. Nestling 2401-67881 was banded at day 16 box 3T-S on 3 July 2010. It also was found dead in box 62-S on 16 July 2010, a distance of 3.65km away. At this point the resident chicks would have fledged within the past 2-4 days. The frequency in which boxes 12-S and 62-S appear in the above observations is remarkable.

Probability of Encounter: Although we have made over 10,000 visits to nests over the past 13 years, it would not be possible to encounter non-resident HY birds visiting other nests until the first nests of the season had fledged young. Therefore, to calculate the overall probability of encountering non-resident HY birds at nests, for each year I summed the number of nest visits that we made once the first nest of the year had fledged, which usually occurs by about 22 days after hatching.[2] Presumably, the breeding chronology of tree swallows away from the study area, but within the vicinity of my sites, would be similar. Using this criteria, we made 3226 visits to active nests (i.e., those that still had resident nestlings present), and as indicated above, I found non-resident HY birds in active nests a total of 6 times (3 live birds in 4 nests, 2 dead birds in 2 nests). Therefore, the overall probability of encountering a non-resident HY tree swallow in an active nest is very low at 0.00186.

Age of Residents During Visits by Non-Residents: In all cases where non-resident birds were detected in nest boxes the resident nestlings were 12 or 16 days old, or else were found dead in boxes where residents had recently fledged. While this might suggest that HY birds that visit other nests may preferentially be choosing those that contain older nestlings, it is also possible that at the point during the season when these visits occur, the only nests available are those with older nestlings. To investigate this, for each instance where a non-resident bird was detected in an active nest (i.e., not including those observations where dead birds were found in nests after the resident nestlings had fledged), I examined the distribution of ages for all nests on the study area that were active on the date the non-resident was detected, and for which we might have visited the nest (16 days old or less). For all encounters with non-resident birds, 41 out of 70 (58%) of the active nests on these days had resident nestlings between 12

and 16 days of age. Therefore, while the majority of active nests had older nestlings when non-residents visited them, there does appear to be a bias towards non-residents preferentially visiting nests with older offspring.

Discussion

My observations suggest that the overall probability of encountering a non-resident HY tree swallow in active nests is a rare event, with the probability of an encounter during a researcher or nest box monitor's visit being less than 0.2%. Such visits by non-residents obviously occur later in the breeding season when resident nestlings are relatively old, but there was some suggestion that non-residents were more likely to be visiting nests with older rather younger nestlings. Nonetheless, the apparent rarity of non-residents visiting nests may simply be a function of the fact that our visits to nest boxes account only for one moment during an entire day, and moreover that non-residents may flush from nest boxes at our approach. Indeed, when Michael Lombardo performed intensive observations (488 h) of 76 nest boxes in New Jersey, including the use of video cameras, non-resident tree swallows were seen at every nest during the brood-rearing period, making a total of 1669 visits, of which 331 were by non-resident HY birds while the remainder were by non-resident adults.[3] While others have observed non-resident tree swallows visiting nests,[e.g., 4] I am unaware of other studies where detailed behavioural observations of this phenomenon been conducted apart from Lombardo's work.[3,5]

Despite the lack of detailed accounts of non-resident visits to nests of tree swallows, several hypotheses have been proposed to explain this behaviour by recently fledged birds. Lombardo proposed the 'exploratory dispersal hypothesis' which suggests that visits by non-resident HY birds late in the year is a consequence of these birds searching for potential future breeding sites.[5] Given that nest sites are often limited for tree swallows,[2] such exploratory behaviour would be beneficial and Lombardo suggested that individuals might visit a number of potential sites, even as they migrate south at the end of the summer.[5] In Lombardo's study, only 3 of 218 (1.4%) of visits by non-resident HY birds were made by those that had fledged from his study area earlier in the year,[5] and my observations and those of Stiles and Taylor[1] also suggest these visits are frequently made by birds from outside the

immediate area. Although this hypothesis has intuitive appeal, there is little evidence to support it, as none of the 45 non-resident HY birds that Lombardo banded were ever recaptured as breeders on his study area.[5]

It has also been suggested that non-resident visitors could be helpers at nests.[3,6] Lombardo, however, found no definitive evidence that non-resident visitors ever passed food to the resident nestlings.[3] Alternatively, non-resident HY visitors may be attempting to procure food from the resident parents. Christine Sheppard, who also observed non-resident HY birds in nests, hypothesized that because they were larger than the offspring in the nests they occupied, that they could outcompete them.[4] Lombardo detailed one anecdotal observation of a non-resident HY visitor trying to steal food from the mouth of a resident chick that had just been fed, while another non-resident was observed to eat a fecal sac in the nest it had visited.[3] While Lombardo never observed a non-resident bird begging for food from resident parents while inside a nest box, they did beg for food from resident adults outside of the box.[3] Parents always ignored this begging, except in one case where a male resident passed food to a begging non-resident outside the box. Non-resident HY birds were in 20 instances observed by Lombardo attempting (unsuccessfully) to steal food from parents as they were flying in the vicinity of the nest box.[3] Overall, there appears to be the most support for the idea that non-resident birds visit nests of other birds in an attempt to secure food resources. The fact that both Stiles and Taylor[1] and myself have found a number of non-resident HY birds dead in nests, presumably from starvation, corroborates the notion that these birds may be having difficulty obtaining sufficient food to meet their energetic demands. Regardless, further observation and research is required to fully understand this phenomenon.

Acknowledgments

I thank the many students that have helped over the years with collecting data on the tree swallow project. Funding in support of my research has been provided primarily by the Natural Sciences and Engineering Research Council of Canada and the University of Northern British Columbia.

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Communal tree swallows at nest box -Dick Stauffer

NOTES and LETTERS

NEWLY FLEDGED TREE SWALLOWS WHICH VISITED OTHER NESTBOXES

DONALD J. STILES[1], WILLIAM P. TAYLOR[2]
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Young tree swallows (*Tachycineta bicolor*) do not usually return to the natal cavity/nest box after first flight.[1] Data gathered from nest boxes located near the Rocky Mountain foothills west of Calgary suggests that some young birds may occasionally enter other boxes in the days after fledging. Boxes here are generally located on roadside fenceposts widely spaced in habitat suitable for the target species, mountain bluebird (*Sialia currocoides*).

Bill Taylor banded nestling swallow 2321-99569 on August 2, 2009. He found it dead, along with a dead hatchling in another of his boxes about 4 km east August 26. Taylor banded a nestling swallow 2511-85400 (estimated 15 days old) in a brood of six in a box NW of Water Valley on July 14, 2013. It was recaptured in another of his boxes with six unbanded young N of Millarville on July 17. Straight-line distance between the boxes is 89 km directly South.

Notes from the late George Loades, a longtime nestbox monitor west of Calgary, indicated that on July 24, 2007, he banded 11 nestlings in one box that on the previous visit(s) had seven young. That same day he found another box with 10 unbanded young that had previously contained only six.

The attached picture, taken by Dick Stauffer on July 24, 2005, late in the season, shows seven Tree Swallows congregating around an active TS nest.

Editor's note: see the Dawson article p. 133 in this issue of Blue Jay for a discussion on this behaviour at sites near Prince George, BC.

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BULLSNAKE ENJOYING A MEAL

TERA EDKINS
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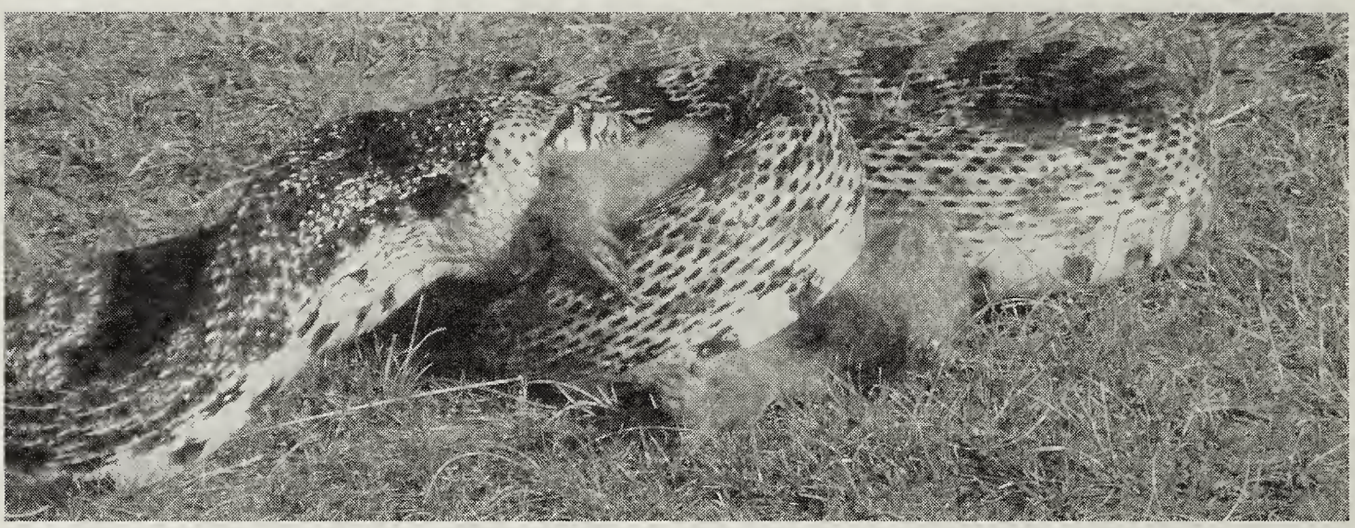

The bullsnake (*Pituophis catenifer sayi*) pictured is enjoying a large ground squirrel as his meal in pasture in the Big Muddy Valley, SK. Bullsnakes are the largest snake species in Canada, with this particular individual measuring 172 cm (5.6 feet). Bullsnakes are constrictors, meaning that they use their powerful bodies to suffocate their prey, which typically consists of ground squirrels and other rodents as depicted here. Though they are large in size, very little is known about bullsnake populations in Canada. So little, in fact, that the bullsnake is considered "Data Deficient" by the Committee on the Status of Endangered Wildlife in Canada.[1] This status means that there is insufficient information to determine whether bullsnakes are at risk of extirpation in Canada. Recent research efforts in Saskatchewan's Frenchman River Valley have shown that bullsnakes move extensively between overwintering dens and summer habitat, requiring much more space to carry out their lifecycle than previously suspected.[2,3]

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‘WHITE’ AMERICAN COOT

GALE DIAKUW
email: *galed@sasktel.net*

I’m a member of the Saskatoon Nature Society and have been for the past summer taking advantage of birding with the senior group called the Golden Eagles, that go out on Thursdays. During our August 27th outing at 10:55 am, just through Radisson on our way to Redberry Lake, one of our members spotted a white coot keeping company with 4 others. I happen to be the only one to capture a picture of it through my passenger side window.

Editor’s note: after some deliberation, our consultants concluded that it is impossible to tell if this coot is albino or leucistic.
If the bill is all pink without a dark tip AND the eye is red then it should be an albino. If the eye is merely dark but not red then it is leucistic and not an albino. Age is hard to know. The Birds of North America mentions 2 specimens with partial leucism, but not any considered albino.

[excerpt from Leucism; Wikipedia]
Leucism (occasionally spelled *leukism*) is a general term for the phenotype resulting from defects in pigment cell differentiation and/or migration from the neural crest to skin, hair, or feathers during development. This results in either the entire surface (if all pigment cells fail to develop) or patches of body surface (if only a subset are defective) having a lack of cells capable of making pigment. Since all pigment cell-types differentiate from the same multipotent precursor cell-type, leucism can cause the reduction in all types of pigment. More common than a complete absence of pigment cells is localized or incomplete hypopigmentation, resulting in irregular patches of white on an animal that otherwise has normal colouring and patterning. This partial leucism is known as a "pied" or "piebald" effect; and the ratio of white to normal-coloured skin can vary considerably not only between generations, but between different offspring from the same parents, and even between members of the same litter.

Albinism results in the reduction of melanin production only, though the melanocyte (or melanophore) is still present. Thus in species that have other pigment cell-types, for example xanthophores, albinos are not entirely white, but instead display a pale yellow colour.

A further difference between albinism and leucism is in eye colour. Due to the lack of melanin production in both the retinal pigmented epithelium (RPE) and iris, albinos typically have red eyes due to the underlying blood vessels showing through. In contrast, most leucistic animals have normally coloured eyes.

MUSHROOM SERIES
STARS OF THE GROUND – THE EARTHSTARS

CHRIS HAY Email: *chris.r.j.hay@gmail.com*

A specimen of Geastrum quadrifidum *reported from La Ronge, SK (Sasata 2010). Note how the arms are reflexed to raise up the spore sac. The mycelial mat below is embedded with litter.*

"Earthstar" is an oxymoron; stars are in the sky, born in the universe, not sitting on the ground having emerged from the earth. But the Latin and Greek roots to their name, "Geastr", mean exactly that: earth (Ge-, as in 'geography') and star (astr-, as in those starry 'aster' flowers). Earthstars are basically a fancy puffball with two layers: the outer peridium splits apart in high humidity and opens up to form a star-like shape, while the inner peridium stays intact so an ordinary puffball sits inside.

The star serves a few purposes. Since the outer peridium only opens at maturity and in wet conditions, the spores are only released when they are fully

formed and have the best chance for germination, otherwise the inner spore sac is shielded and spore release is prevented. Some earthstars will only do this once. Others can open and close multiple times, such as the well-known earthstar Astraeus hygrometricus known as the water measurer or barometer earthstar (hygr- meaning moisture or humidity, metr- for metric, measuring) (Arora 1986).

Often the points of opened stars will reflex, propping up the spore sac with the arms of the star acting like stilts. The added height of a couple centimeters above ground level can substantially improve spore dispersal. Geastrum quadrifidum (four-armed earthstar) is known for this dramatic ballerina-like pose. The epithet fits the common name (quadr- fourfold, fid- divided) but sometimes the star splits five ways. This species also has a little support stalk below the spore sac and a distinct beak around the mouth area (peristome) (Barron 1999).

I remember years ago when I encountered earthstars for the first time. I was in a pine stand and they were scattered all over the needle bed on the ground. It looked like someone dropped a basket of them; they didn't seem to be connected to the ground at all. Apparently some can roll around like tumbleweed after they are fully grown (in dry conditions when closed). My earthstars were completely dry, closed like a tight fist as David Arora would describe (Arora 1986). When I got home I put them in a bowl of shallow water, and sure enough when I checked a few minutes later they had opened! I played with them, tapping the spore sac inside and watching the little brown eruptions. My sister was horrified.

Like most fungi, taxonomy of earthstars is in a process of correction in recent years. Though earthstars would seem to all be closely related, convergent evolution has apparently taken place for this morphological form. The genus Geastrum sits next to stinkhorns, corals, and Gomphus (wooly chanterelle) in the gomphoid-phalloid clade on the fungus phylogenetic tree of life (Pine et al. 1999). Meanwhile Astraeus earthstars are more closely related with boletes (fleshy mushrooms with pores instead of gills). Michael Kuo insists there must be an ecological reason for these strange groupings (Kuo 2004). Perhaps both Astraeus and boletes have always been fond of associating with pine roots. The ecology theory seems like a reasonable idea to me but hasn't

been studied yet. It is likely there aren't enough collections or ecological notes associated with them.

Earthstar taxonomy has also had amendments at the species level. Astraeus hygrometricus used to be considered a widespread species across the globe, but has since been split into several different species. Luckily many of these phylogenetic divisions correspond directly with geography, such as the newly created species A. morganii encompassing North American collections of "A. hygrometricus" (Phosri et al. 2013). Other species from this split are found exclusively in Europe or Asia.

Earthstars are often found in areas with sandy soil and near trees (either hardwood or conifer). After you find them once, you will know when you are in the right area. When you see one, count the number of rays on the star, see if the spore sac has a beak and a stalk, and really, note anything else interesting and unique about it. If you are in an area where collection is permitted, take one home! You can do the barometer test and see if it continues to open and close. At the least, your specimen will make an interesting conversation piece on your mantle.

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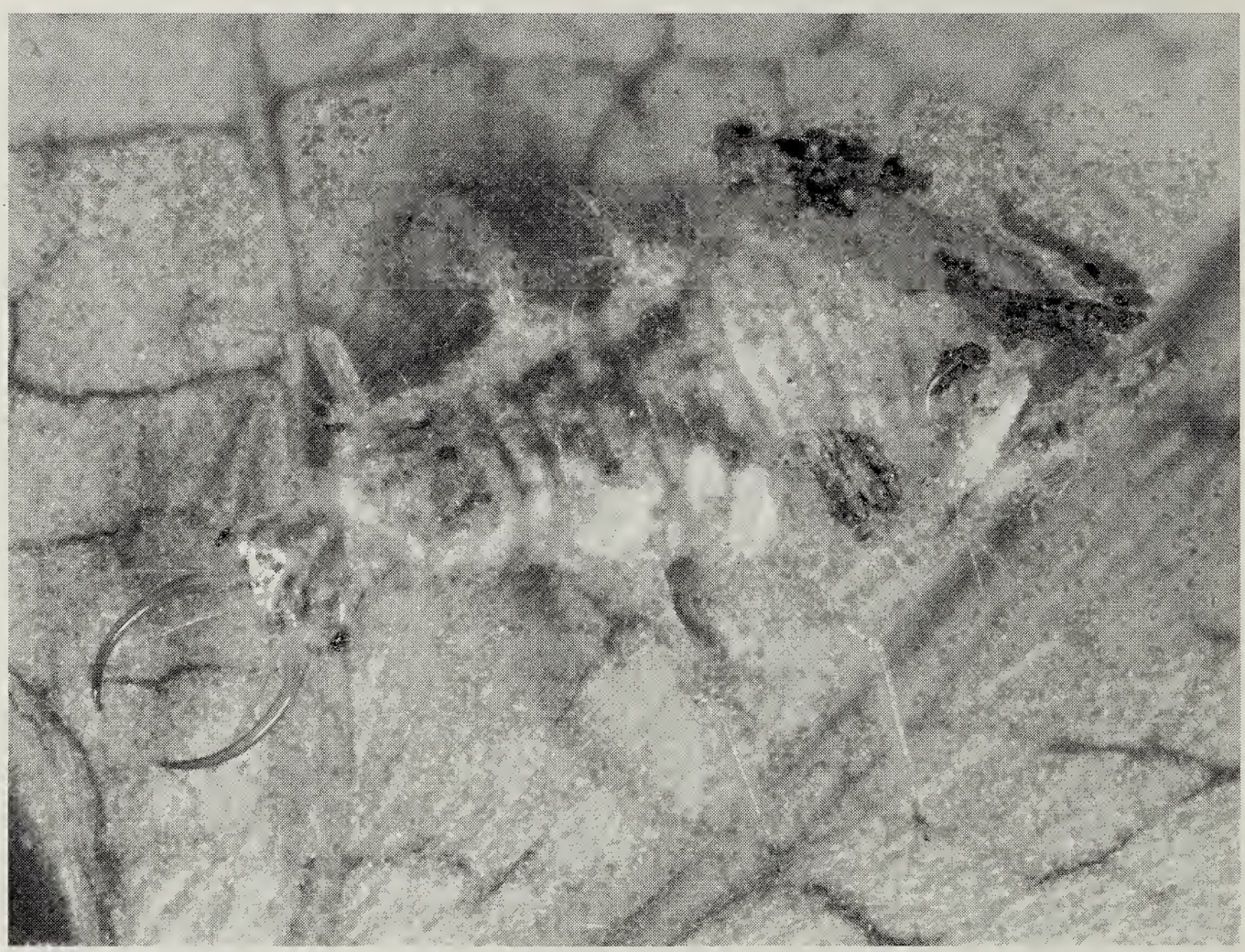
MYSTERY PHOTO

September 2015 Mystery Photo:

Our mystery photo is submitted by Harvey Schmidt.

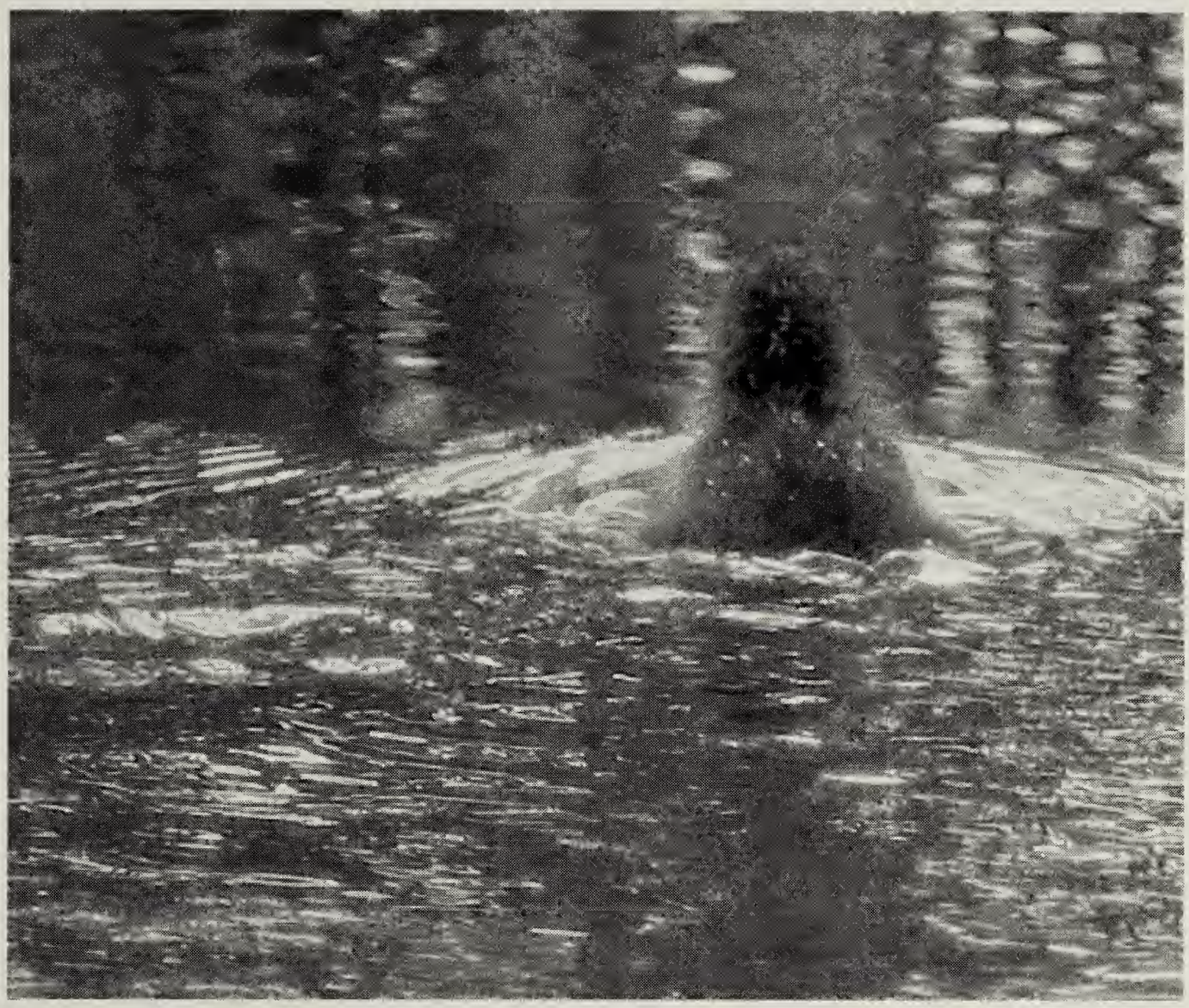
The question is: What is this creature? It is the larva of something that people may be familiar with if you spend time out of doors in the evenings in Saskatchewan.

Please send your answers to the Blue Jay editors:
bluejay@naturesask.ca
Correct answers will be entered into a draw for a prize from Nature Sask.



September Mystery Photo - Harvey Schmidt

June 2015 Mystery Photo Answer:
SPENCER G. SEALY



June 2015 mystery photo *-Anne Brigham*

The Mystery Photo published in the most recent issue of *Blue Jay* (73(2):96, 2015) shows an American Coot (*Fulica americana*) chick swimming away from the photographer. The conspicuous orange, waxy-tipped down that composes the ornamental plumage of the coot's head is visible and contrasts with the black down of the back and rump. The colourful wings are barely visible in the photograph. That the sparse, orange down on the back and rump is gone suggests this chick is at least four or five days old.[1] The brightly coloured bald spot on the top of the head is barely visible in the photograph, but it continues forward to include the forehead and lores. Also not visible in the photograph are the red papillae that surround the eye and the base of the bright red bill, and the white egg tooth on its tip. This plumage is lost between two and three weeks of age.[1,2] A photograph of a downy coot chick only a few hours old is shown in Figure 1.

Figure 1. American Coot within a few hours of hatching, 10 km southwest of Battleford, Saskatchewan, June 1959.

Not surprisingly, the brightly coloured head plumage of recently hatched coots, described as "grotesque" by one author[2], has captured the attention of ornithologists for many decades. Speculation on its function has run the gamut from (1) warning, and possibly thwarting, would-be predators that approach a brood still in the nest[3], (2) enhancing the adults' ability to locate chicks hidden in dense vegetation[4], (3) "liberating" a drive in adults directed towards the care of their young[5], and, by extension, to (4) attraction and stimulation of adults to feed begging young that display this plumage and red bill conspicuously, analogous to the colourful gapes of young altricial species[6]. In a recent study conducted to identify the function of this bizarre ornamental plumage, researchers trimmed the down from some chicks to eliminate the bright colouration of the head and, hence, its signal quality.[7] The results revealed that parents fed ornamented chicks preferentially over the non-ornamented chicks.[7]

Most other species of rail do not develop the brightly coloured head plumage comparable to that of the American Coot and other species of coot. For example, recently hatched Soras (*Porzana carolina*) have only a patch of yellow down, restricted to the chin, whereas Virginia Rails (*Rallus limicola*) lack colourful down feathers altogether (Figure 2).

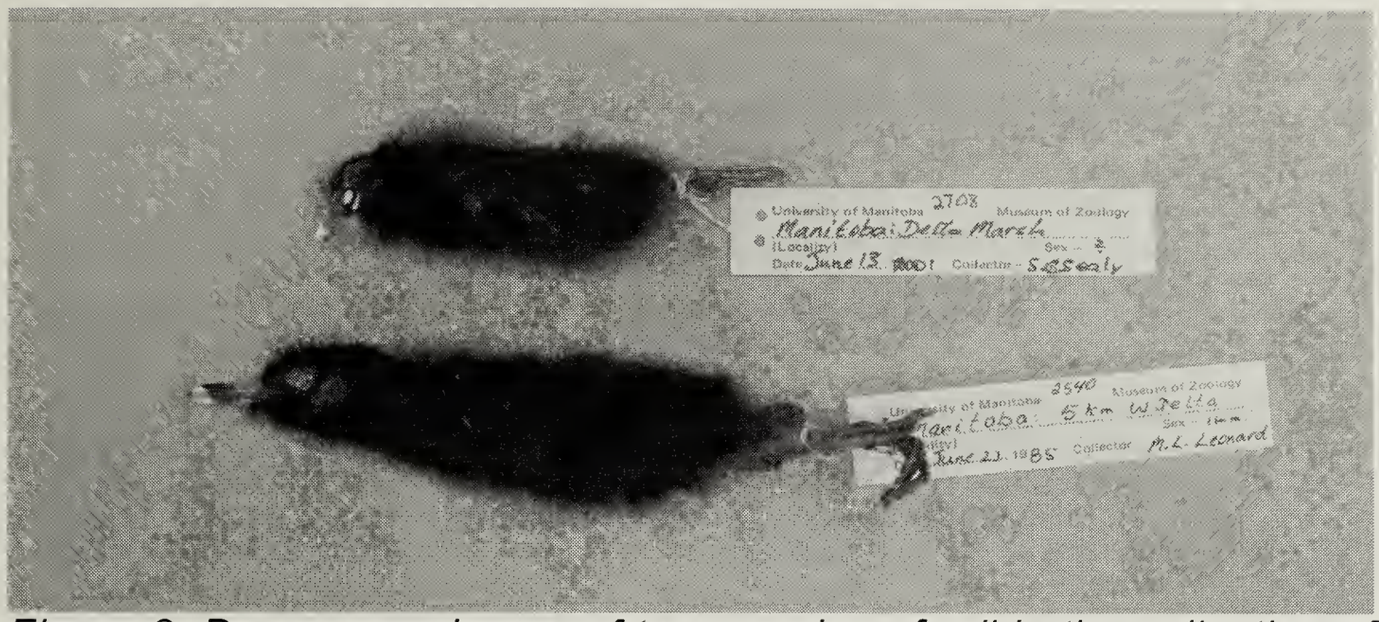


Figure 2. Downy specimens of two species of rail in the collection of the University of Manitoba Zoology Museum (UMZM), found dead at Delta Marsh, Manitoba: above, Sora (UMZM 2708, 13 June 2001); below, Virginia Rail (UMZM 2540, 22 June 1985). Note the white egg teeth on the tips of the bills.

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A specimen of Geastrum quadrifidum *reported from La Ronge, SK (Sasata 2010). Note how the arms are reflexed to raise up the spore sac. The mycelial mat below is embedded with litter.*

-ChrisHay

Prairie crocus (Anemone patens) *-Vladimir V. Kricsfalusy*

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